

The Elephants in the Room – What every physicist should know about string theory

Posted on [November 3, 2015](#) by [woit](#)

The string wars seem to still be going on, with the latest salvos coming from Ashtekar and Witten. In a very interesting [recent interview](#), at the end Ashtekar has some comments about string theory and how it is being pursued. About claims that string theory is the only possible way to get quantum gravity he says:

I don't know why science needs such statements; indeed, scientists should not make such statements. Let the evidence prove that it's the only theory. Let the evidence prove that it is better than other theories or let its predictions be reproduced more than those of others. Science should not become theology. And, somehow such statements have a strong smell of theology, which I don't like.

About AdS/CFT and the current state of its relation to quantum gravity:

We seem to be using these gravity ideas in other domains of physics rather than solving quantum gravity problems. I don't think that the quantum gravity problems have been solved. And I have said this explicitly in conferences with panels – in which Joe Polchinski, Juan Maldacena and I were panellists – that, in my view, this is very powerful and these are good things. However, the AdS/CFT conjecture is the only definition of non-perturbative string

theory one has – and it's a definition, it's not a proof of anything. It talks about duality, but there's no proof of duality. To have a duality, A should be well defined, B should be well defined and then you say that A is dual to B. Since we don't have another definition of string theory, we cannot hope to prove that string theory is dual to its conformal field theory. You can define string theory to be the conformal field theory. You have to construct a dictionary relating string theory in the bulk and conformal field theory on the boundary. That dictionary has not been constructed in complete detail.

Again, nobody is taking anything away from the successes that the AdS/CFT duality has had; but there is a big gap between the successes and the rhetoric. The rhetoric is at a much higher level than the successes. So, for example, in this conjecture, first of all the space-time is 10 dimensional. The physical space-time is supposed to be asymptotically anti-de Sitter, which has a negative cosmological constant. But we look around us, and we find a positive cosmological constant. Secondly, the internal dimensions in the conjecture, or this definition, are macroscopic. The Kaluza-Klein idea is that there are higher dimensions but because they are all wrapped up and microscopic, say, at Planck scale, we don't see them. That's plausible. But here, in AdS/CFT duality, they need the radius of the internal dimensions to be the same as the cosmological radius. If so, if I try to look up I should see these ten dimensions; I don't. So, it can't have much to do with the real world that we actually live in. These are elephants in the room which are not being addressed.

... there are these obvious issues and practitioners just pretend that they don't exist. And that to me is unconscionable; I feel that that's not good science. I don't mean to say string theory is not good science, but publicizing it the way it's done is not good science. I think one should say what it has done, rather than this hyperbole.

A good example of the problems Ashtekar is concerned about is provided by an article in the latest Physics Today by Witten with the title [What Every Physicist Should Know about String theory](#). It's devoted to a simple argument that string theory doesn't have the UV problems of quantum field theory, one that I've seen made by Witten and others in talks and expository articles many times over the last 30 years. This latest version takes ignoring the elephants in the room to an extreme, saying absolutely nothing about the problems with the idea of getting physics this way, even going so far as to not mention the first and most obvious problem, that of the necessity of ten dimensions.

The title of the article is the most disturbing thing about it. Why should every physicist know a heuristic argument for a very speculative idea about unification and quantum gravity, without at the same time knowing what the problems with it are and why it hasn't worked out? This seems to me to carry the "strong smell of theology" that Ashtekar notices in the way the subject is being pursued.

Witten is a great physicist and a very lucid expositor, and the technical story he explains in the article is a very interesting one, with the idea that most physicists might want to hear about it a reasonable one. But the problems with the story also need to be acknowledged and explained, otherwise the whole thing is highly misleading.

Besides the obvious problems of the ten dimensions, supersymmetry, compactifications, the string landscape, etc. that afflict attempts to connect this story to actual physics, there are a couple basic problems with the story itself. The first is that what Witten is explaining as a problematic framework to be generalized by string theory is not quantum field theory, but a first-quantized particle theory, with interactions put in by hand. This can be used to produce the perturbation series of a scalar field theory, but this is something very different than the SM quantum field theory, which has as fundamental objects fields, not particles, with interactions largely

fixed by gauge symmetry, not put in by hand. For such QFTs, there is no necessary problem in the UV: QCD provides an example of such a theory with no ultraviolet problem at all, due to its property of asymptotic freedom.

Another huge elephant in the room ignored by Witten's story is thus that motivating string theory as a natural two-dimensional generalization of one-dimensional theories is that the one-dimensional theories he discusses are known to be a bad starting point, for reasons that go far beyond UV problems. A much better starting point is provided by quantized gauge fields and spinor field coupled to them, which have a very different fundamental structure than that of the terms of a perturbation series of a scalar field theory. A virtue of Witten's story is that it makes very clear (while not mentioning it) what the problem is with this motivation for string theory. All one gets out of it is an analog of something that is the wrong thing in the simpler one-dimensional case. The fundamental issue since the earliest days of string theory has always been "what is non-perturbative string theory?", meaning "what is the theory that has the same relation to strings that QFT has to Witten's one-dimensional story?" After 30 years of intense effort, there is still no known answer to this question. Given the thirty years of heavily oversold publicity for string theory, it is this and the other elephants in the room that every physicist should know about.

Update: For another take on string theory that I meant to point out, there's [an article](#) quoting Michael Turner:

Turner described string theory as an "empty vessel," and added: "the great thing about an empty vessel is that we can put our hopes and dreams in it."

The problem is that the empty vessel is of a rather specific shape, so only certain people's hopes and dreams will fit...

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12 Responses to *The Elephants in the Room – What every physicist should know about string theory*

manfred Requardt *says:*

November 4, 2015 at 3:50 am

What Abhay Ashtekar is saying about String Theory and ADS/CFT is exactly to the point. I think it is a fair description of its scientific status.

Warren *says:*

November 4, 2015 at 6:51 am

You are being too positive.

The real problem is that all approaches to high-energy theoretical physics are seriously flawed.

The Standard Model is not asymptotically free.

Even QCD is not saved by asymptotic freedom, which has the problem of renormalons.

Experience with rigorous approaches, as constructive quantum field theory or lattice gauge theory, has shown us that nonperturbative approaches do not solve perturbative problems.

Loop quantum gravity has problems even with the continuum limit, and doesn't solve renormalizability of gravity, only regularizes it.

But string field theory does exist, & people have addressed nonperturbative problems with it. So rather than denouncing or over-promoting the various alternatives, a more useful attitude would be to just admit that there is no well-defined approach to this problem yet, and recognize the practicality of complementary formulations that are all incomplete.

[martibal](#) *says:*

November 4, 2015 at 8:02 am

Is there a free link to Witten paper ?

Bori *says:*

November 4, 2015 at 8:16 am

Is this just an American phenomenon because of the culture of self-promotion and exaggeration resulting in a natural counter-reaction? Speaking to physicists in Europe, they seem to be more pragmatic about string theory – a certain proportion of positions goes to string theorists and they do their job, but no hype and no bad feelings.

Tammie Lee Haynes *says:*

November 4, 2015 at 9:53 am

Dera Dr Woit

String Theory has “a smell of theology”?

As a Christian, I am astonished that you would make such a statement.

Christianity's claims to being true are based on the accounts of witnesses to certain events such as the miracles of Jesus. The account of what a witness saw is the very definition of empirical evidence. (Of course, from time to time all of us find witness accounts to be non-credible, which is why you are not a Christian)

But the point is this. Before String Theory can claim to have “a smell of theology”, it will need to have support from empirical evidence.

Very truly yours

Tammie Lee Haynes

Charles Day *says:*

November 4, 2015 at 10:45 am

Martibal, click again on the link to the article. You'll find that it's now free.

anonymous *says:*

November 4, 2015 at 12:29 pm

“motivating string theory as a natural two-dimensional generalization of one-dimensional theories is that the one-dimensional theories he discusses are known to be a bad starting point”

Loop quantum gravity itself has a roughly comparable foundational issue : we are assuming that the 3-metric tensor of gravity – or canonically transformed analogues – can be subject to a “quantization” procedure analogous to those developed for fields on Minkowski space-time treated as assemblies of harmonic oscillators : themselves quantized by techniques

developed for non-relativistic finite degrees of freedom.

[Peter Woit](#) says:

November 4, 2015 at 3:50 pm

Warren,

I think there's a difference between elephants in the room (we don't know how to connect string theory to known 4d physics, with or without going to a string field theory) and something much smaller (mice? cockroaches?), such as the renormalon problems or the Landau pole at exponentially large energies.

Charles,

Thanks for making sure that Witten's article is available.

Tammie Lee Haynes,

Perhaps theology is the wrong word. Maybe a better one for some string theory promotional activities would be "evangelical", dedicated to spreading the good word. But, all, please resist temptation to discuss religion here.

Bori,

I don't think there's that much difference between string theorists in the US and Europe. There is a bigger market here for a small number that want to evangelize. However, one thing to say about both Ashtekar and Witten is that they are the sorts who would usually much prefer to stick to the technical details of the science, and not engage in public battles. I can see why Ashtekar might have had enough of the hype over AdS/CFT, I'm not so sure why Witten feels it necessary to make this well-worn claim at this point.

Anonymous,

Sure, a basic problem of quantum gravity is that we don't know what fundamental variables to work with and/or what the correct quantization procedure is. Ashtekar is responsible ("Ashtekar variables") for what seems to me the most intriguing

such choice of variables.

Tom *says:*

November 4, 2015 at 5:27 pm

There's a new book coming out in December, published by CRC press, called "Why String Theory" by a young theoretical physicist named Joseph Conlon (found on Amazon). Though the description seems to indicated it is pro-string theory, does anyone have advance knowledge of its main premise? Just another semi-religious screed, or does it turn on any critical spotlights? (Admittedly, I wasn't interested enough to do a thorough web search.)

garcol euphrates *says:*

November 4, 2015 at 6:17 pm

A link from the interview in the Wire references one of Abhay Ashtekar's formative books on cosmology, Gamow's 1 2 3 ... Infinity. The link referenced contains a reading list of science books (some of my favorites) compiled by a fellow named Robert Anton Wilson, a writer of some stature, who is quoted as:
"Wilson also criticized scientific types with overly rigid belief systems, equating them with religious fundamentalists in their fanaticism."

Full circle!

Peter Woit *says:*

November 4, 2015 at 8:15 pm

Tom,

That book does look like mainly an advertising effort, an expansion of the web-site of the same name:

<http://whystringtheory.com/about/>

I notice there's a chapter on "Direct Experimental Evidence for String Theory". No page numbers, but I'm betting that one's rather short...

[martibal](#) says:

November 5, 2015 at 4:11 am

Thanks Charles !

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